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Comparative study of stationary flats on C-60 V7 Q-pack carding machine with different wire points per square inch and its impact on waste percentage, cotton fiber behaviour and yarn quality

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Abstract

The aim of this paper is to study the working of two different combinations of stationary flats having different wire points per square inch and its impact on waste percentage reduction and cotton fiber behavior. The overall objective is to increase the yield percentage by minimizing the carding waste with the help of stationary flats, and also improving the quality of ring spun yarn. This research is partial to the performance of stationary flats only, and does not involve other parts of carding machine. Further research may be carried out on other parts of the carding machine as well. The paper tries to identify the best combination of stationary flats on C-60 Q-pack carding machine for cotton fiber.

Key words: Stationary Flats & carding machine; Waste percentage Reduction in carding; Impact of Stationary Flats on cotton fiber behavior; wire Points per Square Inch in Stationary Flats

1. Introduction

The process of converting fiber tufts into sliver involves various stages in a carding machine. The first stage is a feeding stage which involves feeding section. In feeding section fiber tufts from blow room are fed into the carding machine by means of two ways, one is via lap sheet feeding; which is a traditional process and the other is via chute feed; which is an advanced process. The method adopted for study in this research work deals with the chute feed process. After getting through feeding section, fiber tufts comes under the action of taker in, and from there it enters into carding section which is the main emphasis of this research. The carding section consists of three sub-sections or zones namely pre-carding zone, post-carding zone and revolving flats zone. The experimental research work deals with the pre-carding and post-carding zone only where the impact of different stationary flats on waste percentage and fibre behaviour is observed. The methodology adopted includes a set of experiments carried out on two pre-selected carding machines. First of all the results were collected from the already installed combination of stationary flats (Table.1) from both the machines and then the previous combination of stationary flats were replaced by new ones (Table.2) and the results were again collected for first and second set respectively.

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The count of yarn selected for observation was Ne 31. Cotton sliver with weight per length as 119 grains/yard was manufactured with the use of C-60 V7 Q-pack version of carding machines. Cotton used for experiment was of middle staple length. The reduction in waste percentage is determined by selecting the fundamental parameters such as neps content per gram, seed count and immature fiber content etc. The parameters selected for fiber behaviour were weight wise fiber length, size wise fiber length, upper quartile length and maturity ratio etc. And the parameters for measuring the yarn quality were count variation, imperfection index and hairiness etc. Eventually all the results were compared to find out the best combination of stationary flats for C-60 carding machine with respect to reduction in waste percentage, increase in yield percentage and improvement in yarn quality.

Table 1 First combination of stationary flats (Set-A)

Pre-Carding	Post-Carding
Trex FD-14A (Qty 2)	Knife FD-32A (Qty 1+1)
Knife FD-14A (Qty 1+1)	Knife FD-32A (Qty 1+1)
Trex FD-32A (Qty 2)	Trex FD-64A (Qty 1)
Knife FD-14A (Qty 1+1)	

Table.1 shows the technical data of the set-A of stationary flats which were used in the experiment. Quantity 2 means the combination of both parts are trex and quantity 1+ 1 means that the combination includes one trex and one mote knife. And 14, 32 and 64 means 140, 320 and 640 wire points per square inch respectively. A is for Alpha angle.

Table 2 Second combination of stationary flats (Set-B)

Pre-Carding	Post-Carding
Trex FD-9A (Qty 2)	Knife FD-42B (Qty 1+1)
Knife FD-42B (Qty 1+1)	Knife FD-42B (Qty 1+1)
Trex FD-42B (Qty 2)	Trex FD-64A (Qty 1)
Knife FD-42B (Qty 1+1)	

Table.2 shows the technical data of the set of stationary flats which were used in the experiment. Quantity 2 means the combination of both parts are trex and quantity 1+ 1 means that the combination includes one trex and one mote knife. And 9, 42 and 64 means 90, 420 and 640 wire points per square inch respectively. B is for Beta angle.

The Trex System (Trex = Trash Extraction) improves fine cleaning by using additional extraction points in the operating area of the cylinder. With great reliability it removes trash, dust and short fibers.

A mote knife arrangement is fitted to a flat of a card or carding machine in a position so as to extend substantially transversely to the carding direction and the mote knife or blade is at an inclination so as to extend in a direction substantially opposite to the carding direction. A steel profile defining the mote knife or blade is provided for the mote knife arrangement. The steel profile is positively retained at a support or carrier which is mountable at the associated flat. The steel profile provided for the mote knife arrangement is retained at the support or carrier by permanent plastic deformation of such support or carrier which has a predetermined profile or sectional shape. The longitudinal direction of the profiled support or carrier also extends substantially transversely to the carding direction.

2. Literature Review

In yarn manufacturing process there are various stages from the opening of cotton tufts up to the packing of yarn[1]. Carding machine is the first to convert fiber tufts into parallelized form i.e. sliver form for the proceeding stages in spinning process. However due to mechanical action of the machine, the fiber staple length is decreased

and short fiber content and Neps formation are increased. The main action of the carding machine is the carding action which takes place between the main cylinder and revolving flats and also between main cylinder and stationary flats[1]. In the carding zone, it is the interaction of the fiber mass and the wire-teeth clothing of cylinder and flats that fully individualizes the fibers and gives parallelism to the fiber mass flow. To minimize the fiber damage, wire points on cylinder, revolving flats and the stationary flats can play a vital role. Carding section of the card machine helps to remove hard trash particles, Neps and seed content and dust from the cotton fiber. Both back and front stationary flats show highly significant effect on yarn evenness and yarn strength [1].
This paper deals with the C-60 carding machine and the performance of stationary flats. The technical data of C-60 machine is given as follows:

The most ideal features of this machine are its working width of 1500mm and its high production rate up to 150kg per hour. The fiber are gently opened by the integrated chute feed system comprising of a fine opener with adjustable feed channel. The licker-in module consists of a feed roller and either 3 rollers or one roller available in different wire densities[2].
There is one very common term used in textile spinning sector i.e., well carded is half spun, which means that if the carding sliver is of good quality then the resulting yarn produced will also have good quality. The quality of yarn depends mainly on the quality of carded sliver[3]. On the other hand, the production cost of spun yarn is becoming higher[4] as a result increasing the demand for cost effective high production machines to produce high quality yarn therefore the machine manufacturers are also emphasizing on the development of high production machines. C-60 is one of the high production carding machines available in the market which can produce up to 150 kg per hour. Modern carding machine can produce card sliver with trash level up to 0.3%[3], from which high quality yarns can be produced. Fig.1 shows the image of C-60 carding machine on which experiment was conducted.

Fig.1. Image of C-60 carding machine

3. Analysis & Discussion

3.1. Set of Stationary Flats

Two machines were selected for the experiment on which same kind of stationary flats were used separately by keeping the other setting of machine as common. Table.3 shows the specifications of stationary flats which were used on machine no.5 and machine no.6 respectively. Set A and Set B are defined to identify the combination and to apply the same on two respective machines simultaneously. Two machines were selected to get more accurate and precise results.

Table.3 Set-A and Set-B of stationary flats on machine number 5 and 6

Mach. No. 5 (Set A)	Mach. No. 5 (Set B)	Mach. No. 6 (Set A)	Mach. No. 6 (Set B)

Pre-Carding	Pre-Carding	Pre-Carding	Pre-Carding
Trex FD14A	Trex FD09A	Trex FD14A	Trex FD09A
Knife FD14A	Knife FD42B	Knife FD14A	Knife FD42B
Trex FD32A	Trex FD42B	Trex FD32A	Trex FD42B
Knife FD14A	Knife FD42B	Knife FD14A	Knife FD42B
Post-Carding	Post-Carding	Post-Carding	Post-Carding
Knife FD32A	Knife FD42B	Knife FD32A	Knife FT660
Knife FD32A	Knife FD42B	Knife FD32A	Knife FT660
Trex FT64A	Trex FT64A	Trex FT64A	Trex FT64A

3.2. Impact on Waste Percentage

Waste percentage is considered to be the most important factor to increase the yield percentage of any process especially in textile spinning sector. The results obtained from the experiments regarding the waste percentage are given in Table.4 and Table.5.

Table.4 Results of waste percentage from Set-A

Mach. No. 5 (Set A)				Mach. No. 6 (Set A)			
Test1 %	Test 2 %	Test 3 %	Average %	Test 1 %	Test 2 %	Test 3 %	Average %
4.29	4.55	4.92	4.58	4.28	4.65	4.80	4.57

Table.5 Results of waste percentage from Set-B

Mach. No. 5 (Set B)				Mach. No. 6 (Set B)			
Test 1 %	Test 2 %	Test 3 %	Average %	Test 1 %	Test 2 %	Test 3 %	Average %
5.09	5.13	5.35	5.19	5.05	5.22	5.40	5.22

From Table.4 and Table.5 it is shown that stationary flats of set A has given less average results i.e., 4.58 % and 4.57 % for waste percentage on machine number 5 and 6 respectively as compared to set B i.e., 5.19 % and 5.22 % on both machines resulting in the increase of yield percentage for set A.

3.3. Impact on Cotton Fiber Behaviour

The mean values obtained to see the impact of the stationary flats on cotton fiber behaviour is given in Table.6. The machine used in the laboratory for testing of the material is AFIS Pro. Regarding the Neps removal efficiency, higher efficiency means good results. The results show that the best Neps removal efficiency is given by machine no 5 set B and after that machine no 6 set B shows good results. As a whole set B gives the best results.
In case of fiber length Set A has shown the best results without damaging the fiber. The impact on maturity ratio is seen as common in both sets of stationary flats. As for as upper quartile length is concerned, Set A has shown the best results without damaging the long fiber content.

Table. 6 Results for cotton fiber behaviour

AFIS- Pro Report:	Mach. No. 5 (Set A)		Mach. No. 5 (Set B)		Mach. No. 6 (Set A)		Mach .No. 6 (Set B)	
	Input	Output	Input	Output	Input	Output	Input	Output
Nep. Cnt/g	265	41	280	18	250	44	244	37
Nep.(um)	718	573	704	590	728	592	717	608
SCN Cnt/g	17	2	18	1	19	3	20	2
SCN (um)	1194	750	1208	875	1176	650	1107	662
L (w) (um)	0.98	0.99	0.99	0.98	1.00	0.98	1.00	0.99
L (w) (in)	35.4	36.0	35.0	36.2	34.0	35.6	34.6	35.2
SFC (w) % 0.50	8.5	8.5	8.6	8.7	7.5	8.8	7.9	8.2
UQL (w) (in)	1.19	1.21	1.21	1.20	1.21	1.20	1.21	1.20

L (n) (in)	0.80	0.81	0.80	0.80	0.82	0.80	0.81	0.81
L (n) %CV	47.6	47.4	47.7	47.2	46.2	47.2	47.2	46.8
SFC (n) % 0.50	23.7	23.2	23.9	23.3	21.7	23.6	22.8	22.6
5.0% (in)	1.38	1.40	1.39	1.40	1.40	1.40	1.40	1.39
Fine mTex.	158	159	157	155	158	157	154	155
IFC (%)	6.7	7.1	8.0	8.1	6.2	7.6	7.6	8.0
Mat. Ratio	0.87	0.87	0.87	0.86	0.88	0.86	0.86	0.86

The impact on fiber behaviour is the most important factor to affect the quality of yarn. If the fiber behaviour is not good at the start of the process then it is very difficult to obtain good results from the end process. This experiment was performed to improve the results of process from the start so that the best quality of yarn can be manufactured.

3.4. *Impact on Yarn Quality of Ne 31*

The yarn count selected for the experiment is Ne 31. The reason for selecting Ne 31 is that it is considered to be the standard count operating in market. The machines used in the laboratory for testing of yarn are Uster Tester 5 (UT-5) and Tensojet 4 (TJ-4). UT-5 is used to obtain the quality parameters of the yarn while TJ-4 is used to measure the strength of yarn. The major parameters to observe the impact on yarn quality are hairiness, Imperfection Index, elongation and count variation in yarn count. The major parameters to observe the impact on strength of yarn is count lea strength product (CLSP), breaking force and tenacity. Table.7 shows the mean values of results produced by UT-5 and TJ-4.

Table.7 Results for yarn quality

Uster 5 Result	Mach. No. 5 (Set A)	Mach. No. 5 (Set B)	Mach. No. 6 (Set A)	Mach .No. 6 (Set B)
U %	12.32	12.47	12.52	12.51
CVm%	15.63	15.84	15.87	15.98
CVm 1m	5.68	5.35	5.46	5.35
CVm 3m	4.56	4.33	4.42	4.32
CVm 10m	3.11	2.88	2.92	2.87
Thin - 30%	2706	3072	3069	3225
Thin - 40%	329.3	409.0	394.8	442.8
Thin - 50%	12.0	20.3	20.3	26.3
Thick + 35%	1011	1126	1193	1168
Thick + 50%	166.5	195.0	203.0	213.0
Neps +140%	1775	2057	2172	2189
Neps +200%	229.0	298.0	317.3	328.5
Neps +280%	18.3	30.3	24.8	29.3
Index	1.69	1.71	1.71	1.71
Rel Cnt.	-0.0	-0,0	-0.0	0.0
H	6.40	6.50	6.54	6.38
Sh	1.47	1.44	1.49	1.40
DR 1,5m 5%	35.8	33.7	32.7	36.1
Total IPI	IPI 407.5	IPI 513.3	IPI 540	IPI 567.8
Strength	75.6	69.7	71.7	69.2
CV%	4.90	6.8	3.69	7.81
CLSP	2348	2198	2250	2201
Ne 31	31.018	31.561	31.345	31.793
Tensojet 4				
B-Force	321.4	308.8	316.1	320.9
Elongation	3.72	2.92	3.38	3.05
Tenacity	16.33	15.68	16.06	16.30

From the results shown in table.7 if we observed all the parameters of yarn quality i.e. hairiness, imperfection index, count variation and elongation it is obvious that set-A proved to be the best combination of stationary flats. Because all the values produced by set-A are better than the values produced by the set-B. In case of hairiness, imperfection index and count variation, less values are considered to be the best one. And regarding the strength,

the highest value is considered to be the best.

4. Conclusion

Based on the results and analysis of the experiments it is concluded that stationary flats do exert a significant impact on quality parameters of the yarn and also on the waste percentage of the carding machine. The combination of stationary flats used in set-A has given the best results regarding the quality of yarn, improvement in the strength of yarn and also the waste percentage reduction in the carding machine or from the carding department. Also due to less waste percentage produced by carding machine, the overall yield percentage can be increased, thereby increasing the productivity of the whole textile unit. In future, an experiment should be performed in other departments of the textile spinning unit to further improve the parameters of quality and productivity of yarn.

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